

**Peer Review Comments on EPA's Draft Document,
*An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay,
Alaska***

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I. GENERAL IMPRESSIONS

Synopsis: EPA's draft document examines the potential impacts of large-scale mining development on the quality, quantity, and genetic diversity of salmonid fish species in the Nushagak River and Kvichak River watersheds of Bristol Bay, Alaska. To the extent that both wildlife and Alaska Native communities in the region depend upon salmonids, fish-mediated impacts to these other "endpoints of interest" are also explored. A hypothetical mining scenario, informed by current exploration, planning, and study in the Pebble deposit area, is described using minimum and maximum estimates for mine production and includes the construction of a transportation corridor to Cook Inlet. Even in the absence of any failures or accidents, construction and operation of such a mine would have significant impacts to salmonids in stream systems proximate to the mine footprint with some related impacts to wildlife and human communities. At least one or more accidents or failures are expected to occur over the long lifetime of the mine. Immediate and long-term severe impacts to salmonids are expected to occur with any significant failure, with relatedly pronounced impacts to wildlife and Alaska Native communities in the region. Multiple mines in the region would amplify these impacts.

General impressions: Overall, the main report is well-written and presents information in multiple ways, including: narrative, conceptual models, images, figures, and tables. The report synthesizes a large amount of information, much of which is described in detail in the report's appendices. The report highlights the unique characteristics of this watershed: incredibly productive and sustainable salmon fisheries, relatively little large-scale modification of the natural environment, and active subsistence-based indigenous cultures still occupying their homelands and many still using their Native language. Making central these features of the watershed, the tone of the report suggests that some negative impacts to salmonids, wildlife, and Alaska Native cultures are necessarily expected to accompany any large-scale mining development and operation in this region.

The document should provide a clear articulation of the scope of human impacts considered in this assessment. The main report considers only *fish-mediated* impacts to *Alaska Native cultures*. The restriction of scope to only fish-mediated impacts should be further clarified. A host of social, cultural, and economic impacts would accompany large-scale mining development in this region. These direct and indirect human impacts, both positive and negative, were the focus of many public comments on the EPA draft document, yet they fall outside of the scope of consideration in this report. If the narrowed scope of

fish-mediated impacts is justified, these other impacts should be clearly identified as outside of the scope of this report. At times in the report (e.g., p 5-77), these other impacts are superficially mentioned. Unless a full treatment of these impacts is included (including a presentation of a large literature explores these impacts internationally, e.g., Ballard and Banks 2003), this cursory discussion should be removed. If maintained, the narrow scope should be reiterated throughout the report to remind the reader that these larger human impacts are not considered.

The report should articulate more clearly why Alaska Native cultures are the only human groups included in the assessment of fish-mediated human impacts. The report notes: “because...Alaska Native cultures are intimately connected and dependent upon fish, ...the culture and human welfare of indigenous peoples, as affected by changes in the fisheries are additional endpoints of the assessment” (ES-1-2). This suggests that the limitation of fish-mediated human considerations to Alaska Native cultures is not due to government-to-government relationship between tribes and the federal government, nor the special status afforded by environmental justice concerns, but rather because of their close connections to, and dependence on fish. Arguably other human groups are also have connections to fish and depend upon on salmon in this region in various ways, but are excluded from analysis of potential impact in this report. This comment is not meant to detract from the importance of the focus on Alaska Native cultures and the primarily indigenous communities in this region for assessing fish-related impacts. Rather the comment is made to suggest the inclusion of a clear justification for this focus, or the broadening of scope to include other human groups who are also connected to, and dependent upon, salmon in this region (e.g., substantial information on the economic dimensions of salmon resources in this region is summarized in Appendix E, but little is presented in the main report). Additionally, the assessment of fish-mediated effects to Alaska Native cultures is primarily focused on subsistence fisheries. More discussion of the role of commercial engagements in salmon fisheries (e.g., commercial harvesting, processing, recreational fishing businesses and employment) in the watershed communities in this region would be helpful.

II. RESPONSE TO CHARGE QUESTIONS

1) The EPA’s assessment focused on identifying the impacts of potential future large-scale mining to the fish habitat and populations in these watersheds. The assessment brought together information to characterize the ecological, geological, and cultural resources of the Nushagak and Kvichak watersheds. Did this characterization provide appropriate background information for the assessment? Was this characterization accurate? Were any significant literature, reports, or data missed that would be useful to complete this characterization, and if so what are they?

The background information presented on the ecological and geological resources of the Nushagak and Kvichak watersheds appears to be appropriate and accurate. The report notes that there is a lack of quantitative data on salmonid populations in this region, lack of a full identification and characterization of salmon presence, spawning, and rearing areas, and a lack of detailed understanding of how local stream and river system features (e.g.,

temperature, habitat structure, predator-prey relationships, limiting factors) affect salmonid production in the region. Further, climate change is noted to be affecting local conditions. These unknowns are important to stress throughout the report.

The cultural characterization presented in Appendix D presents detailed information on historical and contemporary Yup'ik and Dena'ina communities of this region, stressing the centrality of salmon and subsistence in these cultures. This assessment benefits from the time-depth of relationships developed by Boraas and Knott. Overall, this section of the report is based on standard ethnographic methods, although the research design and analysis could be explained in more detail (and described in a separate methods section). The "voices of the people" sections are helpful to present directly the perspectives given by local people. These quotes reveal the complexity of subsistence and contemporary village concerns in this region. At times, the cultural assessment can minimize this complexity.

As detailed in the specific comments below, potential risks and impacts to subsistence are underestimated and at times framed in the report as primarily ones of physical health and economic factors. As described in Appendix D, harvesting, processing, sharing, and consuming wild foods are central to social, cultural, spiritual, psychological, and emotional well-being in Yup'ik and Dena'ina cultures. The subsistence lifestyle is considered central to the health of the people and communities of this region. This is particularly important to note for indigenous communities who continue to cope with the legacies of colonialism. This point is made in Appendix D (but at times could also be strengthened there, as suggested below), and is articulated in some of the quoted interview material.

Recent data on subsistence harvests, use areas, and local context collected for the PLP Environmental Baseline Document (as well as evaluation and discussion of such data, e.g., Langdon et al. 2006) and by the Alaska Department of Fish and Game (e.g., Fall et al. 2012) would be a useful addition to the cultural characterization. Other studies of local traditional ecological knowledge (e.g., Kenner 2005) may help to supplement the assessment of the abundance and distribution of fish species in this region, or to supply information on other less-studied freshwater fishes. Recent research on the contemporary salmon-based livelihoods of the region (e.g., Holen 2011, 2009a, and 2009b; Hebert 2008; Donkersloot 2005) would also be helpful to include. An inclusion of case studies of salmon-based cultures that have suffered depletions of their resource base would add to the presentation of likely fish-mediated impacts to culture (e.g., Colombi and Brooks 2012).

Appendix E also characterized the economic baseline of the region. Why is this dimension not asked about here?

2) A formal mine plan or application is not available for the porphyry copper deposits in the Bristol Bay watershed. EPA developed a hypothetical mine scenario for its risk assessment, based largely on a plan published by Northern Dynasty Minerals. Given the type and location of copper deposits in the watershed, was this hypothetical mine scenario realistic and sufficient for the assessment? Has EPA appropriately bounded the magnitude of potential mine activities with the minimum and maximum mine sizes used in the scenario? Are there significant

literature, reports, or data not referenced that would be useful to refine the mine scenario, and if so what are they?

The hypothetical mine scenario was closely based on a probable mine prospect under development. As such it appears to be realistic and sufficient, if challenging to conceptualize as fully hypothetical given this association.

The report notes that the Pebble deposit may exceed 11 billion metric tons (4-17). The rationale for choosing 6.5 billion metric tons as a maximum size is based “most likely mine to be developed (4-19).” The rationale for not choosing a higher potential maximum could be explained.

3) EPA assumed two potential modes for mining operations: a no-failure mode of operation and a mode involving one or more types of failures. Is the no-failure mode of operation adequately described? Are engineering and mitigation practices sufficiently detailed, reasonable, and consistent? Are significant literature, reports, or data not referenced that would be useful to refine these scenarios, and if so what are they?

The no-failure mode of operation appears to be described adequately. The engineering and mitigation practices appear to be sufficiently detailed, reasonable, and consistent, although I have no particular expertise with which to evaluate this part of the assessment.

It would be helpful to have a clear statement about how well the local (geotechnical, hydrologic, and environmental) conditions in this region have been studied and characterized. How much is understood about the seasonal variation in these conditions and how those variations would affect these scenarios? How well are statistics from mines and TSFs constructed in very different environments likely to apply here?

4) Are the potential risks to salmonid fish due to habitat loss and modification and changes in hydrology and water quality appropriately characterized and described for the no-failure mode of operation? Does the assessment appropriately describe the scale and extent of risks to salmonid fish due to operation of a transportation corridor under the no-failure mode of operation?

Six key direct and indirect mechanisms are identified to pose potential risk to salmonid fish species: eliminated or blocked streams (87.5 – 141.4 km), reduced stream flow, removal of wetlands (10.2-17.3 km), indirect effects of stream and wetlands removal (downstream effects likely diminishing fish production), diminished habitat quality downstream of road crossings, and blocked movement of salmonids at road crossings. These mechanisms are described clearly. The report appears to appropriately describe the scale and extent of risks under a no-failure mode of operation, although I have no particular expertise with which to evaluate this assessment.

5) Do the failures outlined in the assessment reasonably represent potential system failures that could occur at a mine of the type and size outlined in the mine

scenario? Is there a significant type of failure that is not described? Are the probabilities and risks of failures estimated appropriately? Is appropriate information from existing mines used to identify and estimate types and specific failure risks? If not, which existing mines might be relevant for estimating potential mining activities in the Bristol Bay watershed?

The potential failures outlined in this assessment include: tailings dam failures, pipeline failures, water collection and treatment failures, and road and culvert failures. These failures appear to represent the key potential failures for this mining scenario, their risks appear to be estimated reasonably, and statistics from existing mines appear to be used appropriately, although I have no particular expertise with which to evaluate this assessment. As we discussed in our peer review panel, the focus here is on catastrophic failure. More detail should be provided on likely non-catastrophic failures, ones that would be more difficult to detect.

6) Does the assessment appropriately characterize risks to salmonid fish due to a potential failure of water and leachate collection and treatment from the mine site? If not, what suggestions do you have for improving this part of the assessment? Are significant literature, reports, or data not referenced that would be useful to characterize these risks, and if so what are they?

The report concludes that wastewater and leachate treatment and collection failures could expose local streams to mildly to highly toxic water harmful to invertebrates and fish species. Depending on the type of failures, these exposures could last from a period of hours to years. The report notes that in the case of Red Dog Mine, Alaska, the water treatment system was inadequately designed, but does not discuss why such a design was approved and allowed to be implemented, nor does it discuss the likelihood of replicating such a design flaw in future mining scenarios.

7) Does the assessment appropriately characterize risks to salmonid fish due to culvert failures along the transportation corridor? If not, what suggestions do you have for improving this part of the assessment? Are significant literature, reports, or data not referenced that would be useful to characterize these risks, and if so what are they?

Culvert failures due to blockage and erosion are noted to be common and are likely to occur in this scenario. Culvert failures would prevent the movement of fish, which could eliminate a year class from blocked stream systems and fragment upstream and downstream populations, increasing likelihood of localized population depletions and extinctions. Monitoring and maintenance of culverts can be expected to decrease after mine operation, increasing the risks of these failures. The report appears to appropriately characterize risks to salmonid fish due to culvert failures along the transportation corridor, although I have no particular expertise with which to evaluate this assessment.

8) Does the assessment appropriately characterize risks to salmonid fish due to pipeline failures? If not, what suggestions do you have for improving this part of

the assessment? Are significant literature, reports, or data not referenced that would be useful to characterize these risks, and if so what are they?

A pipeline failure would be expected to release toxic leachate into streams systems in the transportation corridor, none of which would dilute the leachate enough to prevent severe toxic effects (both immediate and long-term). The report discusses three pipeline failures in the Bajo de la Alumbrera mine in Argentina. The largest pipeline failure lasted two hours (compared to only two minutes of exposure hypothesized in the current mine scenario). The report could more clearly describe this case and its likely effects. The report appears to appropriately characterize risks to salmonid fish due to pipeline failures, although I have no particular expertise with which to evaluate this assessment.

9) Does the assessment appropriately characterize risks to salmonid fish due to a potential tailings dam failure? If not, what suggestions do you have for improving this part of the assessment? Are significant literature, reports, or data not referenced that would be useful to characterize these risks, and if so what are they?

In the event of a tailings spill, invertebrates and fish would be exposed to toxic tailings and leachate. Actual tailings failures examples suggest the range of exposure would spread to an area more than 100 km. Copper would be especially toxic to invertebrates, fish eggs and larvae. Toxicity would last for decades. The report appears to appropriately characterize risks to salmonid fish due to a potential tailings dam failure, although I have no particular expertise with which to evaluate this assessment.

10) Does the assessment appropriately characterize risks to wildlife and human cultures due to risks to fish? If not, what suggestions do you have for improving this part of the assessment? Are significant literature, reports, or data not referenced that would be useful to characterize these risks, and if so what are they?

Wildlife: The sections discussing risk to wildlife resulting from effects on salmonids are fairly short. Those animals that directly feed on these fish are likely to be impacted, as well as those that depend on other resources enhanced by the marine-derived nutrients supplied by salmon carcasses. The report concludes that the primary aquatic contaminant is copper (5-75), but notes that the ore processing chemicals are unknown, as are their toxicities (5-59). These unknowns could be noted as potential contaminants.

Human cultures: Overall the main report (and Appendix D) describes the central role that salmon play in both Yup'ik and Dena'ina culture, both traditionally and in contemporary communities. As noted above the scope of the assessment focusing on these two cultural groups should be made more clearly. Appendix E, for example, focuses on other human groups local to this region, and those who migrate to the region for commercial fishing and recreation who may also be affected by risk to fish in this region. The vulnerabilities listed in Appendix D (pp 4-5) could be listed in the main report more clearly as risks.

Literature on the effects of contaminated or declining resources on subsistence communities could be utilized to describe in more detail likely impacts. For example, the

report notes: “the actual responses of Alaska Native cultures to any impacts of the mine scenario is uncertain” (ES-26). While the specific responses are uncertain, likely responses can be predicted (and many are articulated in Appendix D). There are data on the psychological, social, cultural, and economic disruptions caused by the Exxon Valdez oil spill (e.g., Braund and Kruse 2009; Palinkas et al. 1993), the cumulative effects of oil and gas development in the North Slope region (e.g., Braund and Associates 2009; NRC 2003), and social impacts related to mining development in Alaska (e.g., TetraTech 2009; Storey and Hamilton 2004). Drawing on some of this literature could help provide likely scenarios for impacts to Alaska Native subsistence-based communities from decreased quality, quantity, or diversity of salmonids. Current and recent responses to salmon shortages in the Yukon-Kuskowkim region may also be helpful to include.

Clearly the impacts to subsistence are not just lost food sources, but lost of healthy subsistence lifeways, loss of practices, loss of cultural connections to the past, loss of connection to specific places, loss of teaching and learning, loss of sharing networks, loss of individual, community, and cultural identity, among others as detailed in Appendix D. This point could be made more forcefully. As noted above and detailed in the specific comments below, subsistence is framed at times in the report as primarily important for physical health and economic necessity. The cultural, social, psychological, and spiritual aspects of subsistence livelihoods should also be consistently highlighted.

As discussed Appendix D, Alaska Native cultures in this region and other regions in the state are also dependent upon the cash economy, both for subsistence production and for other needs. The role of commercial salmon fishing or other wage engagements related to salmon in the study communities, while discussed in Appendix E, is not given much discussion in the main report. How dependent is the subsistence economy upon commercial and recreational fisheries and in this region?

There is a brief mention of non-fish related impacts to Alaska Native communities in the main report (5-77). Unless a full treatment of these impacts (positive and negative) is included, these paragraphs should be removed. While in general, I am supportive of an increased scope (i.e., it is incredibly difficult to isolate only salmon-mediated impacts to Alaska Native communities), these other economic, social, and cultural impacts are not presented fully in the analysis, nor was the ethnographic research designed to investigate these impacts, so passing mention of them here does not seem appropriate.

11) Does the assessment appropriately describe the potential for cumulative risks from multiple mines? If not, what suggestions do you have for improving this part of the assessment?

In general, the report suggests that effects from multiple mines would increase the prevalence and cumulative impacts of the risks described for the one-mine scenario. Again for the cultural assessment, the conclusion is made that effects on humans would be primarily “direct and indirect loss of food sources” (7-15). As the number of large-scale mines increase in this region, the entire subsistence way of life could come under threat. This would be a much larger impact than lost food sources.

- 12) Are there reasonable mitigation measures that would reduce or minimize the mining risks and impacts beyond those already described in the assessment? What are those measures and how should they be integrated into the assessment? Realizing that there are practical issues associated with implementation, what is the likelihood of success of those measures?**

While I do not have knowledge of mitigation measures, a more thorough discussion of mitigation measures could be included. Even if mitigation measures are largely deemed to be ineffective in this case they should be presented and evaluated as such.

- 13) Does the assessment identify and evaluate the uncertainties associated with the identified risks?**

The report includes specific sub-sections to discuss uncertainties for the risks associated with habitat modification (Section 5.2.4), pollutants (5.3.4), and water collection and treatment failure (6.3.4). Uncertainties related to abundance and distribution of fish in watershed draining the mine site, road and stream crossings, salmon-mediated effects on wildlife, salmon-mediated effects on human welfare and Alaska Native cultures, tailings dam failure, pipeline failure, road and culver failures are not discussed in separate sections; however, several uncertainties related to these risks are noted throughout the report, and in summary sections (Sections 8.5 and 8.6).

The “sensitivity relative to overall results” of the key assumptions and uncertainties presented in Table 4.8 in Appendix E (pp 193-195) would be a helpful model to employ in the main report. For non-experts in the technical dimensions of mine construction and operation, uncertain rankings would be useful. For example, “We are “highly uncertain” about the accuracy of these predictions given this unknown factor,” or “We expect this uncertainty has a negligible effect on the model we employ to calculate this risk.”

- 14) Are there any other comments concerning the assessment, which have not yet been addressed by the charge questions, which panel members would like to provide?**

All other comments are contained below.

III. SPECIFIC OBSERVATIONS

Page	Paragraph or Line #	Comment or Question <i>Suggestions for additions added in italics</i>
ES-2	3 rd paragraph (p)	“wildlife and the Alaska Native cultures <i>of this region.</i> ”
ES-5	2 nd p	“Chief among these resources are world-class commercial, sport, <i>and subsistence</i> fisheries for Pacific salmon...”

ES-8	Last p	1. Should Alutiiq (Sugpiaq) cultural group also be included? Alutiiq residents noted in Igiugig and Kokhanok (Appendix D, p 15). 2. Change 2 nd sentence to: “In contrast, the salmon base upon which indigenous peoples in the Pacific Northwest depend is severely threatened.”
ES-9	1st p	“Salmon are integral to the entire way of life in these cultures as subsistence food, <i>fishing and subsistence-based livelihoods</i> , and as the foundation for...”
ES-9	2 nd p	“52% of the subsistence harvest, <i>although for some communities this proportion is substantially higher</i> ” (e.g., noted to be as high as 82% on pg 93 of Appendix D)
ES-10	1 st p	Could also add replacement value for subsistence resources or for salmon, and the range of estimates for economic valuation of subsistence presented in Appendix E, noting of that economic valuations do not fully capture the value of these practices.
ES-14	#1	Are these all the fish spp at risk, or only the one deemed to be commercially, recreationally valuable? Subsistence spp also include others. Should make clear what the focus is.
ES-23	3 rd full p	As noted above, other mines in Alaska (e.g., Red Dog) and oil and gas development studies on North Slope may be useful to include predictions about how subsistence practices will change with mining development and perceived impacts. Including citations with these statements would be helpful.
ES-23/24	Last p	“if salmon quality or quantity is adversely affected (<i>or perceived to be affected</i>)”
ES-26	Last bullet point	There is much data on cultural disruptions caused by the Exxon Valdez oil spill, and cumulative effects of oil and gas development in North Slope region, current salmon shortages in Yukon-Kuskowkim. Clearly subsistence is not about lost food, but about lost lifeways, loss of practices, loss of teaching/learning, loss of identity. This point could be made more forcefully. While the specific impacts may not be entirely predictable, there are likely outcomes that could be included based on experiences in other regions of the state and/or world.
1-2	2 nd p	“this assessment does not provide an economic <i>or social</i> cost/benefit analysis...”
2-15	1 st p	Other important subsistence fish spp not listed in Table 2-5, e.g., whitefish and winter freshwater fish are listed as integral subsistence species in Appendix D. Again make focus here clear.
2-18	Section 2.2.4	The net economic valuation ranges presented in Table 73, Appendix E would be helpful to include here.

2-19	Last full sentence	“because no alternative food sources are economic viable.” This is a bit of a misrepresentation. The point is that people choose to live subsistence lifestyles. Even if food at the stores was cheap, many would choose not to substitute for subsistence hunting, fishing and gathering. This narrow economic framing misses the cultural and lifestyle component of subsistence, and frames it merely as food procurement. This is not the case throughout the document, but in this instance I would suggest changing this sentence to reflect the irreplaceability of the subsistence lifestyle (dependent on access to high-quality foods) rather than the economic viability of substituting alternative food sources.
2-20	First sentence	Here and in Appendix D, the legal framework for federal and state definitions of subsistence should be clarified. Several times in Appendix D an indigenous subsistence priority is noted (e.g., pg 88: “No other state in the United States so broadly grants a subsistence priority to wild foods to indigenous peoples as does Alaska.”). The authors should clarify what they mean by indigenous preference (i.e., as opposed to rural preference?) in state and federal subsistence management. They should include particular references and additional clarifying information.
3-2	1 st p	“would be benign or have no effect on the environment <i>or social systems</i> ,”
3-4	1 st p	“...provide subsistence for Alaska Natives <i>and others</i> .” Particularly because subsistence is defined as a rural right in Alaska, all subsistence users should be included as potentially affected groups.
3-11	Figure 3-2E	This conceptual model appears less developed than the others. It would interesting to work on expanding it out to include missing dimensions; e.g., add health and healing activity (in addition to nutrition), cultural continuity (alongside social relations and linked to language and traditional ways of teaching). With a decrease in economic opportunities comes an increase in reliance on transfer payments. Overall it is a nice illustration, but strikes me as less complete than the others.
4-15	Table 4-3	1. Estimation of 200,000 metric tons of ore processed per day is much higher rate than any of the other mining operations listed in Table 4-4. Is this due to the low/moderate quality of the ore?
4-21	Last p	208 m high dam is “much higher than most existing tailings dams.” What are average dam heights? Or how much higher than most existing tailings dams? Does this high height affect probability of failures?
4-23	2 nd p	“a well field spanning the valley floor.” This is unclear. Could it be added to Fig 4.7. How often would groundwater be monitored?
5-48	1 st full p	“effluents would be required to meet criteria.” How different is treated discharged water from unaffected water?

5-59	2 nd bullet point	Is there any information available on ore processing chemicals, how much are used, and likely toxicities?
5-76	Bullet list	The list of cultural factors that may be negatively impacted could include others: individual, community, and cultural identity; sense of place and place attachments; community sustainability; cultural unity/conflict avoidance.
6-46	Bullet list	In addition to the two listed, another should be added noted that subsistence practices (harvesting, processing, sharing, consuming) are important for psychological, social, emotional, and cultural health and well-being.
6-47	1 st p	"...the physical, <i>psychological, social, and cultural</i> benefits of engaging in a subsistence lifestyle..."
6-47	1 st p	References should be added (and were included earlier in report) for the statement: "would likely employ a small fraction of Alaska Natives."

Specific comments to Appendices:

Appendix D

- Single-space for consistency with the rest of appendices.
- The title is a bit misleading. Only eight pages in the report discuss traditional ecological knowledge, and here not in much depth.
- The research design, methods, and data analysis should be described in more detail. Clarify sampling procedure (both for communities and individuals). For example, it is unclear if younger generations, particularly active subsistence harvesters were targeted as well as elders and culture bearers. Interview protocol should be included clearly as an Appendix.
- This section may make a few overstatements (e.g, "only in Alaska are wild salmon abundant").
- P12 – "those outside of the state." Change to "outside the *region*," as many urban Alaskans are not familiar with subsistence communities.
- P12 "Since the questions dealt with a cultural standard, there were few alternative points of views." Should cultural agreement be a matter of investigation rather than assumed? This statement needs to be justified. Perhaps with the authors' 40+ years of experience working with these communities they have come to expect cultural agreement, especially among elders. If this is the case that should be clearly. To what extent did group interviews (2-6 people interviewed together, except for one single interview) also contribute to cultural agreement? These details are important given that the results are given on an agree/disagree format.
- P17 – 2,378 listed in Table 2 and 2,329 listed here
- P19 – here is perhaps another example of overstatement – 100% of the population has access to waters of the rivers and lakes. What is meant here? For subsistence, this access depends upon having transportation and gear or social relations. Do 100% of people have this in this region?
- P20 reword "the archaeological work is largely due to five projects."

- P26 “located along a salmon stream indicates salmon were *likely* a primary resource.”
- P31-32 – several of these quotes focus on social changes (e.g., elimination of dog teams, relationships to commercial fishing changing over time). People likely harvest less fish now because they do not support dog teams, yet now they need more money for fuel and equipment. These are important considerations for understanding contemporary mixed economy. These points are mentioned in this cultural characterization, but perhaps could be made a bit more clearly. At times even the contemporary characterization reads a bit like “timeless” traditional cultural relationships to the land and resources, yet it is important to accurately characterize the subsistence-based communities in their full contemporary realities and complexities.
- P34 “Large disruptions to the population *have not been documented* to occur until epidemic...”
- P34/35 – both kashgee and qasgiq used for men’s house – it is also defined three times over these first few pages of this section.
- P35 “earlier bow and arrow wars” should either be explained or omitted.
- P38, first full paragraph, last sentence. What is meant by “observe the practice?” This general statement is not adequately supported. Authors should provide specific instances, or more discussion if this point is to be included. As written it risks conveying a static view of TEK and practice and culture. Many indigenous communities in Alaska, e.g., Kodiak villages, while exploited by a colonial economic system, also strategically adapted to benefit from those systems in ways compatible with their village lifestyles (e.g., cannery and village co-dependencies that elder fishermen in this region remember fondly; Carothers 2010). It would be helpful to have more information on this context in this region (e.g., Hébert 2008, Donkersloot 2005).
- P40 – more information would be useful on Alaska Native participation in commercial fishing in this historic period up through the present.
- P47-48 – Ellam yua and tnuhit are defined twice.
- P81-84, Table 9 – second/third part of questions not explained. Since this is an agree/disagree table, remove other questions for which no information is presented. All questions would ideally be contained in an interview protocol attached as an appendix.
- P87 – ‘non-monetized’ – but important to note that modern subsistence economy now depends upon cash inputs (ATVs, boats, snow machines, gas, parts, repairs, guns, nets, etc.).
- P88 first full sentence, last sentence is poorly worded.
- P89-90 the subsistence discussion is confusing.
- P92-93, Tables – update with recent data if possible.
- P100 if percentage of working age population not in labor force is better measure, it should be included rather than official unemployment rates (or in addition too).
- P110 “Villagers in the study also eat store-bought foods, but do not prefer them” – make clear again that most residents interviewed were elders or identified culture bearers. A concern for many subsistence villages in other regions of Alaska is the

displacement of younger generations from fish camp and other subsistence practices, and preferences for store foods, particularly candy and soda. If this region is unique in that regard, make that clear here.

- Section C “Physical and Mental Well-being” -- subsistence for emotional/mental health should be added as a sub-section here. Given the high rates of social problems in Alaska Native villages (e.g., suicide, violence, addiction), many cultures talk about subsistence practices as being healing activities or producing emotion, spiritual and/or mental health. This important aspect isn’t covered in the other sub-sections.
- P113 Makhoul et al is listed as 2010 in references
- P114 change *Local Wild Fish and Local Practices*, and “ecologically, socially, culturally, spiritually, and possibly even evolutionarily.” Point is that subsistence salmon are not just vehicle for protein and nutrition, but form the basis of incredibly important subsistence ways of life that are irreplaceable.
- P115 add ‘cultural and social disruption’ to the list of risks.
- P152 2nd and last bullet points – these are risks of mining development, not of decreased quality/quantity of fish (defined as outside the scope of this assessment). The last bullet point would apply to fish-effects if reworded – some community members may decide it is not safe to eat fish causing factions of those who express concern and those who do not. Others to possibly include: cultural loss as younger generations do not learn the practices of subsistence; stress on other areas and communities of the region where people may target subsistence resources; health risks of eating contaminated fish
- P156 sing to sign;
- Several grammatical errors throughout

Appendix E

- P9 Components of total value should include indigenous homeland for Alaska Native cultural groups.
- P12 Clarify usage of Aleut (Alutiiq/Sugpiaq?)
- P22 and 26 change Boraas citations to Boraas and Knott.
- P32 much of recreational use is non-market and could be included in the list at end of 2nd paragraph.
- P96 citation for typical crew share of 10%?
- P122 Reasons for differences in earnings between local residents and others is important. The mixed subsistence-cash economy and cultural ideas about commercial work in this region may offer an explanation. See: Koslow 1986, Langdon 1986, Carothers 2010.
- P134 Ugashik, Egegik, and South Naknek have over 30.
- P136, last paragraph. This paragraph seems abrupt/misplaced. A more thorough discussion is needed here to include these points.
- P178, section 4.3 – no discussion of role of regional and village Native corporations or the Community Development Quota program for federally-managed fisheries.
- P191, while the majority of formal sector jobs are taken by nonresidents, may want to note that local economy – subsistence – is all local and highly dependent on resources of the region.

- P193 – 2009 is mentioned as an unrepresentative year and given a sensitivity ranking of ‘high.’ More information should be included on the anomalous 2009 – in what direction should we expect to interpret data from this year compared to more average years, or those at other ends of the extremes?
- P195 – number of households engaged in subsistence – ADF&G data should provide estimates.
- P198 – ATV, snow machines, should be added to ‘boats and trucks’; work by Robert Wolfe and others (Wolfe et al. 2009) suggest that about one third of households in Alaska Native village harvest the majority of subsistence foods (and share, esp with the least active households). How does this finding affect these estimates?
- P202 explain why % of adults with 4+ years of college used in this model? The model was not explained clearly enough for me to understand it.
- Some fisheries, e.g., crab fisheries not included in economic analysis, yet depend in part of Bristol Bay ecosystem, as discussed in Appendix F.
- References – Peterson et al. 1992 and Brown and Burch 1992 not included in references

Appendix G

- Mitigation measures are largely concluded to be ineffective. Would be helpful to compare mitigation measures and their success/failure in other mining examples.

Appendix H

- P7 – exposure of groundwater and waterfowl to chemical contaminants are listed as main environmental concerns from tailings storage facilities. Impacts to human health from ingesting contaminated water or birds. Clarify in report that direct risks to human health are not assessed (only through reduction or elimination of subsistence harvests?).

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